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(54) **Desulphating of nitrogen oxide trapping catalyst**

De-Sulfatierung eines NOx-Speicherkatalysators

Désulfuration d'un piège catalytique de NOx

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Description

[0001] This invention relates to an exhaust gas purification device for a vehicle according to the preamble of independent claim 1 and to an exhaust gas purification method for a vehicle according to the preamble of independent claim 13.

[0002] Such a device and such a method can be taken from the prior art document EP 1 059 428 A2. According to said prior art, a deteriorating recovering time is set as a constant with the degree of deterioration of the device.

[0003] Tokkai 2000-73744 published by the Japanese Patent Office in 2000 discloses an exhaust purification device provided with a trapping catalyst which prevents nitrogen oxides (NOx) contained in the exhaust gas from being released into the atmosphere, when running the internal combustion engine at a lean air-fuel ratio.

[0004] The NOx trapping catalyst traps NOx contained in the exhaust gas of the engine when it is run at a lean air-fuel ratio, and releases the trapped NOx when the engine is run at a rich air-fuel ratio. The NOx released by the catalyst is reduced by reducing agents in the exhaust gas such as hydrocarbons (HC) and carbon monoxide (CO) that are generated due to combustion of a fuel mixture of a rich air-fuel ratio, and is discharged into the atmosphere as nitrogen (N_2).

[0005] When the NOx trapping catalyst traps the NOx in the exhaust gas at a lean air-fuel ratio, it also traps sulfur oxides (SOx) in the exhaust gas. The sulfur oxides poisons the catalyst, and the NOx trapping performance declines the more the poisoning by SOx increases.

[0006] In the prior art device, the trapped amount of SOx by the catalyst is computed, and when the computed amount reaches an upper limit, the air-fuel ratio of the air-fuel mixture supplied to engine is temporarily enriched and the exhaust gas temperature is increased. Due to the increase of temperature of the exhaust gas, the SOx trapped by the NOx trapping catalyst is released, and the NOx trapping performance of the NOx trapping catalyst is recovered. This operation is termed desulphating of the NOx trapping catalyst.

[0007] In the prior art device, the SOx release amount during desulphating of the NOx trapping catalyst is calculated based on the assumption that the SOx amount is released from the NOx trapping catalyst at a fixed rate. Desulphating is performed until the trapped SOx amount decreases to a predetermined lower limiting value.

[0008] However, it has been discovered experimentally that the SOx release rate was not fixed, and differed according to the trapped amount. Therefore, if the SOx release amount of the NOx trapping catalyst is calculated by setting the SOx release rate constant, gross errors will arise in the calculation result and the desulphating of the NOx trapping catalyst will not be performed correctly. Unless desulphating is performed correctly, the NOx trapping performance of the NOx trapping catalyst will not necessarily be recovered as desired. Moreover, as desulphating is accompanied by an enriching of the air-fuel ratio, desulphating of low precision brings about an increase of engine fuel consumption.

[0009] It is therefore an objective of this invention to provide an exhaust gas purification device for a vehicle engine and an exhaust gas purification method for a vehicle engine as indicated above, respectively, wherein high purification performance is achieved.

[0010] According to the apparatus aspect of the present invention, that objective is solved by an exhaust gas purification device for a vehicle engine having the features of independent claim 1. Preferred embodiments are laid down in the dependent claims.

[0011] Furthermore, said objective is also solved by an exhaust gas purification method for a vehicle engine having the features of independent claim 13.

[0012] Accordingly, there is provided an exhaust gas purification device for a vehicle engine. The device comprises a nitrogen oxide trapping catalyst which traps nitrogen oxides in exhaust gas and the engine comprises a mechanism which removes sulphur oxides which have poisoned the nitrogen oxide trapping catalyst from the nitrogen oxide trapping catalyst.

[0013] The device further comprises a sensor which detects a running condition of the vehicle, and a programmable controller programmed to calculate a sulphur oxide poisoning amount of the nitrogen oxide trapping catalyst from the running condition of the vehicle, start operation of the mechanism when the sulphur oxide poisoning amount reaches a predetermined amount, set a decrease amount per unit time of the sulphur oxide poisoning amount during operation of the mechanism as a parameter based on the sulphur oxide poisoning amount, calculate the sulphur oxide poisoning amount during operation of the mechanism based on an integral value of the decrease amount per unit time, and after operation of the mechanism has started, stop operation of the mechanism when the sulphur oxide poisoning amount has decreased to a predetermined desulphating completion equivalent value.

[0014] Moreover, there is also provided an exhaust gas purification method for such a vehicle engine that comprises a nitrogen oxide trapping catalyst which traps nitrogen oxides in exhaust gas, a mechanism for removing sulphur oxides which have poisoned the nitrogen oxide trapping catalyst from the nitrogen oxide trapping catalyst.

[0015] The method comprises detecting a running condition of the vehicle, calculating a sulphur oxide poisoning amount of the nitrogen oxide trapping catalyst from the running condition of the vehicle, starting operation of the removing mechanism when the sulphur oxide poisoning amount reaches a predetermined amount, setting a decrease amount per unit time of the sulphur oxide poisoning amount during operation of the removing mechanism as a parameter based on the sulphur oxide poisoning amount, calculating the sulphur oxide poisoning amount during operation of the removing mechanism based on an integral value of the decrease amount per unit time, and stopping, after operation of the removing mechanism has started, operation of the removing mechanism when the sulphur oxide poisoning amount has decreased to a predetermined desulphating completion equivalent value.

[0016] Hereinafter, the present invention is illustrated and explained by means of preferred embodiments in conjunction with the accompanying drawings. In the drawings wherein:

[0017] FIG. 1 is a schematic diagram of an internal combustion engine provided with an exhaust purification device according to the present teaching.

[0018] FIG. 2 is a flowchart describing a desulphating routine of a NOx trapping catalyst performed by a controller according to the present teaching.

[0019] FIG. 3 is a diagram showing a relation between the duration of SOx desulphating and a SOx cumulative amount found experimentally

[0020] FIG. 4 is a diagram describing the characteristics of a desulphating constant table stored by the controller.

[0021] FIGs. 5A-5D are timing charts describing the desulphating operation performed by the controller.

[0022] FIG. 6 is a flowchart describing an air-fuel ratio control subroutine performed by the controller according to a second embodiment of the present teaching.

[0023] FIG. 7 is a diagram describing the characteristics of a map of an excess air factor stored by the controller according to the second embodiment of the present teaching.

[0024] Referring to FIG. 1 of the drawings, a multi-cylinder four-stroke cycle direct injection gasoline engine 1 for a vehicle comprises an intake passage 2 which aspirates air to a combustion chamber 1A formed in each cylinder, and an exhaust passage 9 which discharges the exhaust gas from the combustion chamber 1A.

[0025] The intake passage 2 is connected to the combustion chamber 1A via a collector 21 and intake manifold 22. An air flow meter 7 which detects the intake air amount, and a throttle 8 which regulates the intake air amount, are provided in the intake passage 2. A fuel injector 3 injects fuel into the air aspirated into the combustion chamber 1A and generates an air-fuel mixture. The air-fuel mixture burns due to a spark plug 4 provided in the combustion chamber 1A which ignites the air-fuel mixture.

[0026] The exhaust gas due to combustion of the air-fuel mixture is discharged into the atmosphere via a catalytic converter 5 disposed midway along the exhaust passage 9. Part of the exhaust gas is returned to the intake air through an exhaust gas recirculation (EGR) passage 12 which connects the collector 21 with the exhaust passage 9. The EGR passage 12 is provided with an EGR valve 14 which regulates the exhaust gas recirculation amount.

[0027] The nitrogen oxide (NOx) contained in the exhaust gas of the air-fuel mixture having a lean air-fuel ratio is trapped by a NOx trapping catalyst 5A contained in the catalytic converter 5. The NOx trapping catalyst 5A releases the trapped NOx and promotes the reduction thereof when it meets the exhaust gas generated from an air-fuel mixture having a rich air-fuel ratio. A controller 6 controls the fuel injection timing and injection period of the fuel injector 3, ignition timing of the spark plug 4, and the opening of the EGR valve 14 by signals.

[0028] The controller 6 comprises a microcomputer provided with a central processing unit (CPU), a read-only memory (ROM), a random access memory (RAM) and an input/output interface (I/O interface). The controller 6 may also comprise plural microcomputers.

[0029] For this control, signals are input to the controller 6 from a throttle opening sensor 18 which detects the opening of the throttle 8, an engine rotation sensor 19 which detects a rotation speed of the engine 1, a vehicle speed sensor 20 which detects a running speed of the vehicle, a water temperature sensor 15 which detects a cooling water temperature of the engine 1, and a universal exhaust gas oxygen sensor 10 which detects the air -fuel ratio of the air -fuel mixture burnt by the engine 1 from the exhaust gas composition of the exhaust passage 2, respectively.

[0030] In the steady state of the engine 1, by controlling the fuel injection amount of the fuel injector 3, the controller 6 burns an air-fuel mixture having a lean air-fuel ratio with less fuel than the stoichiometric air-fuel ratio. The NOx trapping catalyst of the catalytic converter 5 traps the NOx contained in the exhaust gas of the engine 1 in this state. On the other hand, if the NOx trapping catalyst traps a predetermined amount of NOx, by controlling the fuel injection amount of the fuel injector 3, the controller 6 burns an air-fuel mixture having a rich air-fuel ratio with more fuel than the stoichiometric air-fuel ratio, and regenerates the NOx trapping catalyst by releasing the NOx trapped by the NOx trapping catalyst and reducing NOx by HC and CO, which are reducing agents contained in exhaust gas generated under a rich air-fuel ratio.

[0031] Apart from the NOx trapping and regeneration of this catalyst, the controller 6 calculates a SOx cumulative amount of the NOx trapping catalyst in the catalytic converter 5. The SOx cumulative amount is calculated by accumulating a NOx trap amount of the catalyst per unit time.

[0032] If the SOx cumulative amount reaches a predetermined amount, the controller 6 performs desulphating. Here, desulphating is a general term for three kinds of control, i.e., making the air -fuel ratio of the air-fuel mixture burnt in the engine 1 richer by controlling the fuel injection amount of the fuel injector 3, delaying the ignition timing of the spark plug 4, and stopping EGR by controlling the EGR valve 4. The enrichment of the air-fuel ratio promotes reduction of SOx released from the NOx trapping catalyst. The delay of ignition timing and stopping of EGR bring about a rise of exhaust temperature required to make the NOx trapping catalyst release SOx.

[0033] The controller 6 calculates the SOx cumulative amount of the NOx trapping catalyst as follows during desulphating. The SOx release amount per unit time released by desulphating is calculated, and the SOx cumulative amount per unit time is calculated by deducting the SOx release amount per unit time from the SOx trap amount per unit time. As the SOx release amount per unit time exceeds the SOx trap amount per unit time during desulphating, the SOx cumulative amount per unit time is a negative value that makes the SOx cumulative amount decrease. The controller 6 terminates desulphating when the SOx cumulative amount becomes zero. The SOx release amount per unit time in this calculation process, i.e., the SOx release rate, is not fixed.

[0034] Referring to FIG. 3, the variation in the SOx cumulative amount with respect to the length of the SOx desulphating operation can be represented by a curve as shown in the drawing. This curve is obtained at a constant vehicle speed at which the SOx trapping rate of the NOx trapping catalyst is constant. The slope of the curve in this drawing is therefore considered to represent the SOx release rate. The curve shows that the SOx release rate is larger, the larger the SOx cumulative amount becomes, and the SOx release rate is large in the early stages of the SOx desulphating operation. Unless the calculation of the variation in the SOx cumulative amount is performed correctly, the completion of desulphating cannot be determined correctly. Consequently, if desulphating is terminated before desulphating is completed, the NOx trapping performance of the NOx trapping catalyst will not fully recover. On the other hand, if desulphating is continued even after desulphating is completed, the fuel consumption of the engine 1 will increase.

[0035] The controller 6 calculates a SOx release amount per unit time *RSMILE,* i.e., a SOx release rate, using equation (1), considering the characteristics of the SOx release rate as mentioned above.

[0036]

$$RSMILE = SOXMILE_{-1} \cdot RSMILE1 + RSMILE2 \tag{1}$$

where, $SOXMILE_{-1}$ = the SOx cumulative amount *SOXMILE* one unit time ago, and
RSMILE1, RSMILE2= coefficients.

[0037] The coefficients *RS MILE1, RS MILE2* are set experimentally beforehand. The SOx release rate *RSMILE* is equal to the slope of the curve of the variation in the SOx cumulative amount shown in FIG. 3. Equation (1) calculates the SOX release rate *RSMILE* at the point X in FIG. 3, by calculating the slope of the straight line connecting the points X and Y separated by the unit time. As shown in FIG. 3, the SOx release rate is larger, the larger the SOX cumulative amount *SOXMILE* becomes.

[0038] If the coefficients *RS MILE1* and *RSMILE2* are defined , it is possible to summarize a table showing the relation between the SOx cumulative amount *SOXMILE* and the SOx release rate *RSMILE* in FIG. 4. In this table, the SOx cumulative amount is divided into five regions by four boundary values, *SXMIL1 - SXMIL4,* and the SOx release rate *RSMILE* is set as five fixed values, *RSML 1 - RSML5*, according to the region.

[0039] Here, *SXMIL 1 > SXMIL2 >SXMIL3 > SXMIL4 > SXMIL5,* and *RSML 1 > RSML2 > RSML3 > RS ML 4 > RSML5.*

[0040] That is, the SOx release rate *RSMILE* is larger the SOx cumulative amount *SOXMILE* becomes. This table or a map specifying the same characteristics is stored beforehand in the memory of the controller 6, and the controller 6 can also obtain the SOx decreasing rate *RSMILE* from the SOx cumulative amount *SOXMILE* by looking up the prestored table or map.

[0041] Now, if the exhaust temperature exceeds 650°C even when desulphating is not performed, the NOx trapping catalyst will release trapped SOx. Therefore, if this temperature condition holds, the controller 6 calculates the SOx cumulative amount considering the variation characteristics of the SOx cumulative amount in the same way as when desulphating is performed, even if desulphating is not performed.

[0042] Next, the desulphating routine performed for the above control by the controller 6 will be described, referring to FIG. 2. This routine is performed at an interval of ten milliseconds during the running of the engine.

[0043] The controller 6 reads the vehicle speed *V* detected by the vehicle speed sensor 20 in a step S1.

[0044] In a following step S2, the SOX cumulative amount $SOXMILE_{-1}$ calculated on the immediately occasion when the routine was performed, is compared with an upper limiting value *SOXFUL*. The upper limiting value *SOXFUL* is a value for determining whether desulphating of the NOx trapping catalyst is performed, and is set as a value equivalent to ten percent of the physical upper limiting value of the SOx trap or poisoning of the NOx trapping catalyst.

[0045] The SOx cumulative amount *SOXMILE* in this routine while desulphating is not performed is converted into and expressed in mileage of vehicle travel. Correspondingly, the upper limiting value *SOXFUL* is expressed in mileage. Therefore, if the physical upper limiting value of the SOx cumulative amount of the NOx trapping catalyst is 8000km, the upper limiting value *SOXFUL* is 800km.

[0046] Now, in the step S2, if the SOX cumulative amount $SOXMILE_{-1}$ calculated on the immediately occasion when the routine was performed does not exceed the upper limiting value *SOXFUL*, the controller 6 determines whether or not the desulphating flag *FLS1* is unity in a step S4. The desulphating flag *FLS1* is a flag which is set to unity when the SOX poisoning amount S*OXMILE* calculated on the immediately occasion when the routine was performed exceeds the upper limiting value *SOXFUL,* and it is reset to zero when desulphating is completed. Therefore, when the desulphating flag *FLS1* is zero, it shows that the desulphating operation is not required. When the desulphating flag *FLS1* is unity, it shows that the desulphating operation is required.

[0047] When the desulphating flag *FLS1* is unity in the step S4, the controller 6 processes a step S5. When the desulphating flag *FLS1* is not unity, i.e., in the case of zero, the controller 6 determines whether or not the vehicle speed *V* has reached the predetermined speed *VSP2* in a step S8.

[0048] As mentioned above, the NOx trapping catalyst releases SOx when the exhaust gas is at a high temperature of 650°C or more even if desulphating is not performed. As the exhaust gas temperature is higher the faster the vehicle runs, according to this routine, it is determined whether or not the exhaust gas temperature exceeds 650°C by determining whether or not the vehicle speed *V* exceeds the predetermined speed *VSP2.* The predetermined speed *VSP2 is* therefore a vehicle speed corresponding to the exhaust temperature of 650°C, for example, 110-120 km/hr. Here, the predetermined speed *VSP2* is set to 110 km/hr. The predetermined speed *VSP2* is preferably determined experimentally beforehand.

[0049] If the vehicle speed *V* does not exceed the predetermined speed *VS P2* in the step S8, the NOx trapping catalyst does not release SOx. In this case, the controller 6 performs the processing of a step S12 after setting the SOx release rate *RSMILE* to zero in a step S9. When the vehicle speed *V* exceeds the predetermined speed *VSP2* in the step S8, the NOx trapping catalyst releases SOx. In this case, the controller 6 processes the step S11.

[0050] Now, in the step S2, when the SOX cumulative amount $SOXMILE_{-1}$ exceeds the upper limiting value *SOXFUL*, desulphating is required. In this case, in the step S3, the controller 6 sets the desulphating operation flag *FLS1* to unity.

[0051] In a following step S5, it is determined whether or not the vehicle speed *V* has reached the predetermined speed *VSP1.* The predetermined velocity *VSP1* is a value for determining whether or not the minimum exhaust temperature required to release SOx is obtained by performing desulphating of the NOx trapping catalyst. As mentioned above, from the relation between exhaust gas temperature and vehicle speed *V*, if the vehicle speed has reached the predetermined speed *VSP1*, it is determined that the NOx trapping catalyst can release SOx by desulphating. On the other hand, if the vehicle speed *V* has not reached the predetermined speed *VSP1*, it is determined that the NOx trapping catalyst does not release SOx even if desulphating is performed.

[0052] Here, the predetermined speed *VSP1* is determined as follows.

[0053] That is, it is determined taking consideration of whether the temperature of the NOx trapping catalyst reaches the SOx release temperature of 650°C by performing desulphating. In other words, the vehicle speed equivalent to a temperature obtained by deducting a temperature rise part due to desulphating from 650°C, is *VSP1.* Although the temperature rise due to desulphating changes with the specification of the exhaust purification device or engine, it is considered to be from 70°C to 100°C. As a result, if the exhaust temperature is 550°C to 580°C, the exhaust gas temperature will reach 650°C by desulphating. The vehicle speed equivalent to the exhaust gas temperature of 550°C-580°C is, for example, 90-100 km/hr. Here, the predetermined vehicle speed *VSP1* is set to 90 km/hr. It is desirable to set the predetermined vehicle speed *VSP1* by determining it experimentally beforehand.

[0054] Now, in the step S5, if the vehicle speed *V* has reached the predetermined speed *VSP1,* the controller 6 will perform desulphating in the step S10. Desulphating means three operations, i.e. enrichment of the air-fuel ratio of the air-fuel mixture by increasing the fuel injection amount of the fuel injector 3, delay of ignition timing of the spark plug 4, and closing of the EGR valve 4 as mentioned above.

[0055] These operations are performed by signals output from the controller 6 to the fuel injector 3, spark plug 4 and EGR valve 14.

[0056] As seen from the flowcharts, desulphating is performed in the step S10 if it is determined that the SOx cumulative amount $SOXMILE_{-1}$, exceeds the upper limiting value *SOXFUL* in the step S2, or desulphating is continuing in the step S4, in addition to the condition that the exhaust gas temperature represented by the vehicle speed *V* is in a region suitable for desulphating.

[0057] After desulphating, in a step S11, the controller 6 calculates the SOx release rate *RSMILE* using the above-mentioned equation (1).

[0058] As the NOx trapping catalyst releases SOx when the vehicle speed *V* exceeds the predetermined speed *VSP2* in the step S8, even if desulphating is not performed, the SOx release rate *RSMILE is* calculated in the step S11 also in that case. The controller 6 processes the step S12 after the processing of the step S11.

[0059] On the other hand, if the vehicle speed *V* has not reached the predetermined speed *VSP1* in the step S5, the controller 6 sets the SOx release rate *RSMILE* to zero in the step S6.

[0060] In the following step S7, the controller 6 stops desulphating by a signal output to the fuel injector 3, spark plug 4 and EGR valve 14. The controller 6 processes the step S12 after the processing of the step S7.

[0061] In the step S12, the controller 6 calculates a SOx trap amount ΔV per unit time. The SOx amount trapped by the NOx trapping catalyst has an intimate relation with the mileage of the vehicle. The mileage is obtained by integrating the vehicle speed *V*. Here, the cumulative amount SOx ΔV per unit time corresponding to the execution interval of the routine, is calculated as a difference of an integral *Vx* of the vehicle speed *V,* and an integral Vx_{-1} on the immediately preceding occasion when the routine was performed. In other words, the SOx trap amount ΔV per unit time is represented by the mileage achieved per unit time.

[0062] In the following step S13, the controller 6 calculates the SOx cumulative amount *SOXMILE* by the next equation (2) using the SOx release rate *RSMILE* which were set in the steps S6, S9 or S11, and the SOx trap amount ΔV per unit time.

[0063]

$$SOXMILE = SOXMILE_{-1} + \Delta V - RSMILE \tag{2}$$

where, $SOXMILE_{-1}$ = *SOXMILE* calculated on the immediately preceding occasion the routine was executed.

[0064] In the following step S14, it is determined whether the SOx cumulative amount *SOXMILE* is zero. This is a step which determines whether or not SOx desulphating was completed. When the SOX cumulative amount *SOXMILE is* zero, the controller 6 resets the desulphating flag *FLS1* to zero in a step S15.

[0065] In a following step S16, the controller 6 stops desulphating as in the processing of the step S7 by signals output to the fuel injector 3, spark plug 4 and the EGR valve 14. The engine 1 is therefore run at an air-fuel ratio, ignition timing and exhaust gas recirculation amount which are usually applied to normal running. The controller 6 processes the step S17 after the processing of the step S16.

[0066] In the step S14, when the SOx cumulative amount *SOXMILE* is not zero, steps S15 and S16 are skipped and the step S17 is processed.

[0067] In the step S17, after storing the mileage *Vx* and the SOx cumulative amount *SOXMILE* in a memory as Vx_{-1}, $SOXMILE_{-1}$, respectively, the controller 6 terminates the routine.

[0068] In the step S14, it is determined whether or not desulphating is complete by determining whether or not the SOX cumulative amount *SOXMILE is* zero, but whether or not desulphating is complete can also be determined by setting a minimum valve of the SOx cumulative amount at which the NOx trapping catalyst effectively completes SOx release, and comparing this minimum value with the SOx cumulative amount *SOXMILE.*

[0069] Next, the variation of the SOx cumulative amount *SOXMILE* of the NOx trapping catalyst in the aforesaid routine will be described referring to FIGs. 5A-5D.

[0070] The SOx cumulative amount *SOXMILE* of the NOx trapping catalyst increases with the vehicle running distance. If the vehicle speed *V* exceeds the predetermined speed *VSP2* during a run as shown in section A of FIG. 5B, the NOx catalyst temperature will rise above 650°C, and the NOx trapping catalyst will release SOx. Consequently, as shown in FIG. 5A, the SOx cumulative amount *SOXMILE* decreases.

[0071] If the section in which the vehicle speed *V* does not exceed the predetermined vehicle speed *VSP2* continues for some time, the SOx cumulative amount *SOXMILE* of the NOx trapping catalyst continues to increase, and eventually exceeds the upper limiting value *SOXFUL* shown by the point B of FIG. 5A. Consequently, the desulphating flag *FLS1 changes* from zero to unity as shown in FIG. 5C. However, if the vehicle speed *V* at this time does not exceed the predetermined speed *VSP1,* the controller 6 does not perform desulphating.

[0072] When the desulphating flag *FLS1* is unity, and the vehicle speed *V* exceeds the predetermined velocity *VSP1* as shown by the point C of FIG. 5B, the controller 6 performs desulphating as shown by FIG. 5D, and release of SOx from the NOx trapping catalyst is promoted due to enrichment of the air fuel ratio and rise in temperature of the exhaust gas. As a result, the SOx cumulative amount *SOXMILE* decreases and eventually becomes zero as shown by the point F in FIG. 5A. When the SOx cumulative amount *SOXMILE* becomes zero, the controller 6 stops desulphating as shown by FIG. 5D.

[0073] As can be seen from FIG. 5A, the decrease of the SOx cumulative amount *SOXMILE* of the NOx trapping catalyst is not linear, but the decrease rate increases the larger the SOX poisoning amount *SOXMILE* becomes, and in the latter half of SOx release, the decrease rate of the SOx cumulative amount *SOXMILE* gradually becomes smaller. In this case, if it was assumed that the SOx release rate *RSMILE is* a fixed value, and the SOx cumulative amount *SOXMILE* is calculated based on the constant release rate, the timing when the SOx desulphating procedure is completed will be largely different from the timing when the SOx desulphating procedure is actually completed.

[0074] In this exhaust gas purification device, as shown by the step S11 of the routine of FIG. 2, the controller 6 calculates the SOx release amount *RSMILE* using a coefficient *RSMILE1* set according to the elapsed time from the start of desulphating, and a coefficient *RSMILE2* set based on the SOx cumulative amount *SOXMILE.* The SOx cumulative amount *SOXMILE* can therefore -precisely trace the actual variation in the SOx cumulative amount of the NOx trapping catalyst.

[0075] Therefore, desulphating is performed not too much and not too little, and release of SOx can be completed in a short time without wastage. The increase of fuel consumption due to desulphating can also be suppressed to the lowest limit. Further, the fact that completion of SOx release can be precisely known has a desirable effect on the determining precision of desulphating on the next occasion.

[0076] On the other hand, even during the desulphating period when the desulphating flag *FLS1* is unity, when the vehicle speed *V* is less than the predetermined vehicle speed *VSP1,* as the exhaust gas temperature is too low, the NOx trapping catalyst cannot release SOx even if desulphating is performed. In this case, desulphating is prevented from being performed in the step S7 of the routine of FIG. 2, so an increase in the fuel consumption which does not contribute to promote SOx release is also prevented. The region D in FIG. 5B corresponds to this state. Thus, if desulphating is interrupted due to the lowering of the vehicle speed *V,* a desulphating flag *FLS1* can be held at unity as shown in FIG. 5C. Desulphating is then performed when the vehicle speed *V* reaches the predetermined vehicle speed *VSP1* at a point E in FIG. 5B. While the desulphating is being interrupted, the SOx release rate *RSMILE* is set to zero in the step S6, so the calculation precision of the SOx cumulative amount *SOXMILE* is not impaired while desulphating is interrupted.

[0077] Next, a second embodiment of the present teaching will be described referring to FIGs. 6. 7.

[0078] This embodiment relates to desulphating performed by the controller 6 in the step S10 of FIG. 2. In this embodiment, when the controller 6 performs desulphating, the richness of the air-fuel ratio of the air-fuel mixture burnt by the engine 1 is varied according to the SOx cumulative amount *SOXMILE* by performing the subroutine shown in FIG. 6.

[0079] Specifically, first in a step S101, the controller 6 calculates a rich correction amount of an excess air factor by looking up a map having the characteristics shown in FIG. 7 which is prestored in the memory of the controller 6, based on the SOx cumulative amount $SOXMILE_{-1}$.

[0080] Here, the excess air factor is a value obtained by dividing the air-fuel ratio by the stoichiometric air-fuel ratio, where unity denotes the stoichiometric air-fuel ratio, a value larger than unity denotes a lean air-fuel ratio and a value less than unity denotes a rich air-fuel ratio.

[0081] The map shown in FIG. 7 has characteristics such that the excess air factor approaches unity, the smaller the SOx cumulative amount *SOXMILE* during desulphating becomes. In this map, the excess air factor during desulphating is set to 0.99, and the excess air factor decreases as the SOx cumulative amount *SOXMILE* increases. In other words, the richness of the air-fuel ratio increases. The controller 6 determines a target excess air factor from this map, and calculates a correction amount of the fuel injection amount corresponding to the difference between the excess air factor for desulphating and the target excess air factor for the state where desulphating is not performed.

[0082] In a next step 102, the target fuel injection amount is corrected by the correction amount.

[0083] In a next step S103, the controller 6 outputs a signal corresponding to the corrected target fuel injection amount to the fuel injector 3, and terminates the routine.

[0084] In this way, regarding the desulphating of the step S10, varying the richness of the air-fuel of the air-fuel mixture which is burnt by the engine 1 according to the SOx cumulative amount *SOXMILE is* desirable from the viewpoint of suppressing increase of fuel consumption accompanying the desulphating process.

[0085] When the SOx cumulative amount *SOXMILE* is near zero, as seen from FIG. 3, the SOx release rate *RSMILE is* small, and *RSMILE* does not increase even if the air-fuel ratio is enriched. In this embodiment, in this case, a rich air-fuel ratio near the stoichiometric air-fuel ratio is applied, so ineffective fuel consumption can be prevented.

[0086] Alternatively to the embodiments described above, as a variation of the air-fuel ratio control, instead of setting a target air-fuel ratio according to the SOx cumulative amount *SOXMILE*, a target air-fuel ratio can also be set according to the elapsed time from the start of desulphating. In this case, the rich air-fuel ratio is made to approach the stoichiometric air-fuel ratio as the elapsed time increases. Also, after desulphating is interrupted due to a decrease of the vehicle speed, the desulphating may be resumed in a state where the SOx cumulative amount *SOXMILE is* less than the upper limiting value *SOXFUL*. In this case, to perform appropriate air-fuel ratio control, the target air-fuel ratio when desulphating starts may be set according to the SOx cumulative amount *SOXMILE.* In the above description, the SOx cumulative amount *SOXMILE* corresponds to the sulphur oxide poisoning amount, and the decrease rate of SOx cumulative amount *SOXMIL E,* i.e., ΔV - *RSMILE,* corresponds to the decrease amount per unit time of the sulphur oxide poisoning amount.

Claims

1. An exhaust gas purification device for a vehicle engine (1) comprising:

a nitrogen oxide trapping catalyst (5A) which traps nitrogen oxides in exhaust gas, the engine (1) comprising a mechanism (3, 4, 14) which removes sulphur oxides which have poisoned the nitrogen oxide trapping catalyst (5A) from the nitrogen oxide trapping catalyst (5A);
a sensor (20) which detects a running condition of the vehicle; and
a programmable controller (6) programmed to:

calculate a sulphur oxide poisoning amount of the nitrogen oxide trapping catalyst (5A) from the running condition of the vehicle (S13);
start operation of the mechanism (3, 4, 14) when the sulphur oxide poisoning amount reaches a predetermined amount (S2); and
after operation of the mechanism (3, 4, 14) has started, stop operation of the mechanism (3, 4, 14) when the sulphur oxide poisoning amount has decreased to a predetermined desulphating completion equivalent value (S14, S16),

characterized in that the programmable controller (6) is further programmed to:

set a decrease amount per unit time of the sulphur oxide poisoning amount during operation of the mechanism (3, 4, 14) as a parameter based on the sulphur oxide poisoning amount (S11); and
calculate the sulphur oxide poisoning amount during operation of the mechanism (3, 4, 14) based on an integral value of the decrease amount per unit time (S13).

2. An exhaust gas purification device according to claim 1, **characterized in that** the controller (6) is further programmed to set the decrease amount per unit time to a larger value, the larger the sulphur oxide poisoning amount becomes (S 11).

3. An exhaust gas purification device according to claim 1 or 2, **characterized in that** the controller (6) is further programmed to set the decrease amount per unit time to a smaller value as an elapsed time from start-up of the mechanism (3, 4, 14) increases (S11).

4. An exhaust gas purification device according to any one of claim 1 to 3, **characterized in that** the exhaust gas purification device further comprises a sensor (20) which detects a temperature of the exhaust gas, and the controller (6) is further programmed not to start operation of the mechanism (3, 4, 14) when the temperature of the exhaust gas is less than a predetermined temperature (S5, S7).

5. An exhaust gas purification device according to claim 4, **characterized in that** the controller (6) is further programmed to stop operation of the mechanism (3, 4, 14), when the temperature of the exhaust gas is less than the predetermined temperature after the mechanism (3, 4, 14) has started.

6. An exhaust gas purification device according to claim 4 or 5, **characterized in that** the temperature sensor comprises a sensor (20) which detects a running speed of the vehicle.

7. An exhaust gas purification device according to any one of claim 4 to 6, **characterized in that** the controller (6) is further programmed to set, when the exhaust gas temperature exceeds a second predetermined temperature higher than the predetermined temperature while the mechanism (3, 4, 14) is operating, the decrease amount per unit time of the sulphur oxide poisoning amount as a parameter based on the sulphur oxide poisoning amount (S11), and the sulphur oxide poisoning amount is calculated based on the integral value of the decrease amount per unit time (S13).

8. An exhaust gas purification device according to any one of claim 1 to 7, **characterized in that** the running condition detecting sensor comprises a sensor (20) which detects a running speed of the vehicle, and the controller (6) is further programmed to calculate the sulphur oxide poisoning amount based on the integral value of the running speed (S12, S13).

9. An exhaust gas purification device according to any one of claim1 to 8, **characterized in that** the mechanism (3, 4, 14) comprises a fuel injector (3) which injects fuel, a spark plug (4) which ignites the fuel and an exhaust gas recirculation valve (14) which recirculates part of the exhaust gas of the engine (1) into an intake air of the engine (1), and wherein the mechanism (3, 4, 14) removes sulphur oxides from the nitrogen trapping catalyst (5A) by enriching an air-fuel ratio of the intake air and the fuel by increasing the fuel injection amount of the fuel injector (3), and by raising the exhaust gas temperature by delaying the ignition timing of the spark plug (4) and closing the exhaust gas recirculation valve (14).

10. An exhaust gas purification device according to claim 9, **characterized in that** the controller (6) is further programmed to vary a richness of the air-fuel ratio based on the sulphur oxide poisoning amount during operation of the mechanism (3, 4, 14) (S101, S102).

11. An exhaust gas purification device according to claim 10, **characterized in that** the controller (6) is further programmed to decrease the richness of the air-fuel ratio as the sulphur oxide poisoning amount decreases during operation of the mechanism (3, 4, 14) (S101, S102).

12. An exhaust gas purification device according to any one of claim1 to 11, **characterized in that** the controller (6) is further programmed to set the decrease amount per unit time of the sulphur oxide poisoning amount during operation of the mechanism by the following equation:

$$RSMILE = SOXMILE_{-1} \cdot RSMILE1 + RSMILE2$$

where,

RSMILE = the decrease amount per unit time,
$SOXMILE_{-1}$ = the sulphur oxide poisoning amount SOXMILE one unit time ago, and
RSMILE1, = a coefficient which becomes smaller as an elapsed time from start-up of the removing means increases, and
SMILE2 = a coefficient which becomes larger as the $SOXMILE_{-1}$ becomes larger.

13. An exhaust gas purification method for a vehicle engine (1), the engine (1) comprising a nitrogen oxide trapping catalyst (5A) which traps nitrogen oxides in exhaust gas, means (3, 4, 14) for removing sulphur oxides which have poisoned the nitrogen oxide trapping catalyst (5A) from the nitrogen oxide trapping catalyst (5A), the method comprising:

detecting a running condition of the vehicle;
calculating a sulphur oxide poisoning amount of the nitrogen oxide trapping catalyst (5A) from the running condition of the vehicle;
starting operation of the removing means (3, 4, 14) when the sulphur oxide poisoning amount reaches a predetermined amount; and
stopping, after operation of the removing mechanism (3, 4, 14) has started, operation of the removing means (3, 4, 14) when the sulphur oxide poisoning amount has decreased to a predetermined desulphating completion equivalent value,

characterized by
setting a decrease amount per unit time of the sulphur oxide poisoning amount during operation of the removing means (3, 4, 14) as a parameter based on the sulphur oxide poisoning amount; and
calculating the sulphur oxide poisoning amount during operation of the removing means based on an integral value of the decrease amount per unit time.

Patentansprüche

1. Abgasreinigungsvorrichtung für einen Fahrzeugmotor (1), aufweisend:

einen Stickoxid- Speicherkatalysator (5A), der Stickoxide im Abgas speichert, wobei der Motor (1) eine Vorrichtung (3, 4, 14) aufweist, die Schwefeloxide, die den Stickstoffoxid- Speicherkatalysator (5A) vergiftet haben, aus dem Stickstoffoxid-Speicherkatalysator (5A) entfernt;
einen Sensor (20), der eine Fahrbedingung des Fahrzeuges erfasst; und
eine programmierbare Steuerung (6), programmiert zum:

Berechnen einer Schwefeloxidvergiftungsmenge des Stickoxid- Speicherkatalysator (5A) aus der Fahrbedingung des Fahrzeuges (S13);
den Start des Betriebs der Vorrichtung (3, 4, 14), wenn die Schwefeloxidvergiftungsmenge eine vorbestimmte Menge (S2) erreicht; und
nachdem der Betrieb der Vorrichtung (3, 4, 14) gestartet worden ist, Stoppen des Betriebs der Vorrichtung (3, 4, 14), wenn sich die Schwefeloxidvergiftungsmenge auf einen vorbestimmten Äquivalentwert für den Abschluss der Entschwefelung (S14, S16) vermindert hat,

dadurch gekennzeichnet, dass die programmierbare Steuerung (6) außerdem programmiert ist, zum:

Festlegen einer Verminderungsmenge pro Zeiteinheit der Schwefeloxidvergiftungsmenge während des Betriebs der Vorrichtung (3, 4, 14) als ein Parameter auf der Grundlage der Schwefeloxidvergiftungsmenge (S11); und Berechnen der Schwefeloxidvergiftungsmenge während des Betriebs der Vorrichtung (3, 4, 14) auf der Grundlage eines Integralwertes der Verminderungsmenge pro Zeiteinheit (S13).

2. Abgasreinigungsvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Steuerung (6) außerdem programmiert ist, die Verminderungsmenge pro Zeiteinheit auf einen größeren Wert festzulegen, je größer die Schwefeloxidvergiftungsmenge (S11) wird.

3. Abgasreinigungsvorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Steuerung (6) außerdem programmiert ist, die Verminderungsmenge pro Zeiteinheit auf einen kleineren Wert festzulegen, wie sich eine vergangene Zeit vom Starten der Vorrichtung (3, 4, 14) erhöht (S11).

4. Abgasreinigungsvorrichtung nach einem von Anspruch 1 bis 3, **dadurch gekennzeichnet, dass** die Abgasreinigungsvorrichtung außerdem aufweist einen Sensor (20), der eine Temperatur des Abgases erfasst, und die Steuerung (6) außerdem programmiert ist, den Betrieb der Vorrichtung (3, 4, 14) nicht zu starten, wenn die Temperatur des Abgases niedriger als eine vorbestimmte Temperatur (S5, S7) ist.

5. Abgasreinigungsvorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** die Steuerung (6) außerdem programmiert ist, den Betrieb der Vorrichtung (3, 4, 14) zu stoppen, wenn die Temperatur des Abgases niedriger als die vorbestimmte Temperatur ist, nachdem die Vorrichtung (3, 4, 14) gestartet worden ist.

6. Abgasreinigungsvorrichtung nach Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** der Temperatursensor einen Sensor (20) aufweist, der eine Fahrgeschwindigkeit des Fahrzeuges erfasst.

7. Abgasreinigungsvorrichtung nach einem von Anspruch 4 bis 6, **dadurch gekennzeichnet, dass** die Steuerung (6) programmiert ist, festzulegen, wenn die Abgastemperatur eine zweite vorbestimmte Temperatur, höher als die vorbestimmte Temperatur, überschreitet, während die Vorrichtung (3, 4, 14) in Betrieb ist, die Verminderungsmenge pro Zeiteinheit der Schwefeloxidvergiftungsmenge als einen Parameter auf der Grundlage der Schwefeloxidvergiftungsmenge (S11) festzulegen und die Schwefeloxidvergiftungsmenge berechnet wird auf der Grundlage des Integralwertes der Verminderungsmenge pro Zeiteinheit (S13).

8. Abgasreinigungsvorrichtung nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** der Fahrbedingungs- Erfassungssensor einen Sensor (20) aufweist, der eine Fahrgeschwindigkeit des Fahrzeug erfasst, und die Steuerung (6) außerdem programmiert ist, die Schwefeloxidvergiftungsmenge auf der Grundlage des Integralwertes der Fahrgeschwindigkeit (S12, S13) zu berechnen.

9. Abgasreinigungsvorrichtung nach einem von Anspruch 1 bis 8, **dadurch gekennzeichnet, dass** die Vorrichtung (3, 4, 14) aufweist einen Kraftstoffeinspritzer (3), der Kraftstoff einspritzt, eine Zündkerze (4), die den Kraftstoff zündet, und ein Abgasrückführungsventil (14), das einen Teil des Abgases des Motors (1) in eine Einlassluft des Motors (1) rückführt, und wobei die Vorrichtung (3, 4, 14) Schwefeloxide aus dem Stickstoffspeicherkatalysator (5A) entfernt durch Anreichern des Luft- Kraftstoff- Verhältnisses der Einlassluft und des Kraftstoffes durch Erhöhung der Einspritzmenge des Kraftstoffeinspritzers (3), und durch Anheben der Abgastemperatur durch Verzögern des Zündzeitpunktes der Zündkerze (4) und Schließen des Abgasrückführungsventils (14).

10. Abgasreinigungsvorrichtung nach Anspruch 9, **dadurch gekennzeichnet, dass** die Steuerung (6) außerdem programmiert ist, die Fettheit des Luft- Kraftstoff-Verhältnisses auf der Grundlage der Schwefeloxidvergiftungsmenge während des Betriebs der Vorrichtung (3, 4, 14) zu variieren (S101, S102).

11. Abgasreinigungsvorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** die Steuerung (6) außerdem programmiert ist, die Fettheit des Luft- Kraftstoff-Verhältnisses zu vermindern, wie sich die Schwefeloxidvergiftungsmenge während des Betriebs der Vorrichtung (3, 4, 14) vermindert (S101, S102).

12. Abgasreinigungsvorrichtung nach einem von Anspruch 1 bis 11, **dadurch gekennzeichnet, dass** die Steuerung (6) außerdem programmiert ist, die Verminderungsmenge pro Zeiteinheit der Schwefeloxidvergiftungsmenge während des Betriebs der Vorrichtung durch die folgende Gleichung festzulegen:

$$RSMILE = SOXMILE1_1 \cdot RSMILE1 + RSMILE2$$

wo
RSMILE = die Verminderungsmenge pro Zeiteinheit,
$SOXMILE_1$ = die Schwefeloxidvergiftungsmenge SOXMILE einer Zeiteinheit vorher, und
$RSMILE1_1$ = ein Koeffizient ist, der kleiner wird, wenn sich die vergangene Zeit vom Start der Einrichtung zum Entfernen erhöht, und
RSMILE2 = ein Koeffizient ist, der größer wird, wenn SOXMILE, größer wird.

13. Abgasreinigungsverfahren für einen Fahrzeugmotor (1), wobei der Motor (1) aufweist einen Stickoxid- Speicherkatalysator (5A), der Stickoxide im Abgas speichert, eine Einrichtung (3, 4, 14) zum Entfernen von Schwefeloxiden, die den Stickoxid- Speicherkatalysator (5A) vergiftet haben, aus dem Stickoxid- Speicherkatalysator (5A), wobei das Verfahren aufweist:

Erfassen einer Fahrbedingung des Fahrzeuges;
Berechnen der Schwefeloxidvergiftungsmenge des Stickstoffoxid- Speicherkatalysators (5A) aus der Fahrbedingung des Fahrzeuges;
Starten des Betriebs der Einrichtung zum Entfernen (3, 4, 14), wenn die Schwefeloxidvergiftungsmenge eine vorbestimmte Menge erreicht; und
Stoppen, nach dem Betrieb der Einrichtung zum Entfernen (3, 4, 14) gestartet worden ist, Betreiben der Einrichtung zum Entfernen (3, 4, 14), wenn die Schwefeloxidvergiftungsmenge sich auf einen vorbestimmten Äquivalenzwert des Abschlusses der Entschwefelung vermindert hat,

gekennzeichnet durch
Festlegen einer Verminderungsmenge pro Zeiteinheit der Schwefeloxidvergiftungsmenge während des Betriebs der Einrichtung zum Entfernen (3, 4, 14) als ein Parameter auf der Grundlage der Schwefeloxidvergiftungsmenge; und
Berechnen der Schwefeloxidvergiftungsmenge während des Betriebs der Einrichtung zum Entfernen auf der Grundlage eines Integralwertes der Verminderungsmenge pro Zeiteinheit.

Revendications

1. Dispositif de purification de gaz d'échappement pour un moteur de véhicule (1) comprenant :

un catalyseur à piégeage de monoxyde d'azote (5A) qui piège les monoxydes d'azote dans un gaz d'échappement, le moteur (1) comprenant un mécanisme (3, 4, 14) qui supprime les oxydes de souffre, ayant empoisonné le catalyseur à piégeage de monoxyde d'azote (5A), du catalyseur à piégeage de monoxyde d'azote (5A) ; une sonde (20) qui détecte un état de roulement du véhicule ; et un dispositif de commande programmable (6) programmé pour :

calculer une quantité d'empoisonnement aux oxydes de souffre du catalyseur à piégeage de monoxyde d'azote (5A) à partir de l'état de roulement du véhicule (S13) ;
commencer le fonctionnement du mécanisme (3, 4, 14) lorsque la quantité d'empoisonnement aux oxydes de souffre atteint une quantité prédéterminée (S2) ; et
après que le fonctionnement du mécanisme (3, 4, 14) a commencé, arrêter le fonctionnement du mécanisme (3, 4, 14) lorsque la quantité d'empoisonnement aux oxydes de souffre a diminué à une valeur prédéterminée équivalente à l'achèvement de la désulfuration (S14, S16),

caractérisé en ce que le dispositif de commande programmable (6) est en outre programmé pour :

établir une quantité de diminution par unité de temps de la quantité d'empoisonnement aux oxydes de souffre pendant le fonctionnement du mécanisme (3, 4, 14) comme paramètre basé sur la quantité d'empoisonnement aux oxydes de souffre (S11) ; et
calculer la quantité d'empoisonnement aux oxydes de souffre pendant le fonctionnement du mécanisme (3, 4,

14) basée sur une valeur entière de la quantité de diminution par unité de temps (S13).

2. Dispositif de purification de gaz d'échappement selon la revendication 1, **caractérisé en ce que** le dispositif de commande (6) est programmé en outre pour établir la quantité de diminution par unité de temps à une valeur supérieure, plus la quantité d'empoisonnement aux oxydes de souffre augmente (S11).

3. Dispositif de purification de gaz d'échappement selon la revendication 1 ou 2, **caractérisé en ce que** le dispositif de commande (6) est programmé, en outre, pour établir la quantité de diminution par unité de temps à une valeur inférieure lorsque le temps écoulé depuis le démarrage du mécanisme (3, 4, 14) augmente (S11).

4. Dispositif de purification de gaz d'échappement selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le dispositif de purification de gaz d'échappement comprend, en outre, une sonde (20) qui détecte une température du gaz d'échappement, et le dispositif de commande (6) est programmé, en outre, pour ne pas commencer le fonctionnement du mécanisme (3, 4, 14) lorsque la température du gaz d'échappement est inférieure à une température prédéterminée (S5, S7).

5. Dispositif de purification de gaz d'échappement selon la revendication 4, **caractérisé en ce que** le dispositif de commande (6) est programmé, en outre, pour arrêter le fonctionnement du mécanisme (3, 4, 14) lorsque la température du gaz d'échappement est inférieure à la température prédéterminée après que le mécanisme (3, 4, 14) a démarré.

6. Dispositif de purification de gaz d'échappement selon la revendication 4 ou 5, **caractérisé en ce que** la sonde de température comprend une sonde (20) qui détecte une vitesse de roulement du véhicule.

7. Dispositif de purification de gaz d'échappement selon l'une quelconque des revendications 4 à 6, **caractérisé en ce que** le dispositif de commande (6) est en outre programmé pour établir, lorsque la température de gaz d'échappement excède une deuxième température prédéterminée supérieure à la température prédéterminée alors que le mécanisme (3, 4, 14) fonctionne, la quantité de diminution par unité de temps de la quantité d'empoisonnement aux oxydes de souffre comme paramètre basé sur la quantité d'empoisonnement aux oxydes de souffre (S11), et la quantité d'empoisonnement aux oxydes de souffre est calculée en étant basée sur la valeur entière de la quantité de diminution par unité de temps (S13).

8. Dispositif de purification de gaz d'échappement selon l'une quelconque des revendications 1 à 7, **caractérisé en ce que** la sonde de détection de l'état de roulement comprend une sonde (20) qui détecte une vitesse de roulement du véhicule, et le dispositif de commande (6) est programmé, en outre, pour calculer la quantité d'empoisonnement aux oxydes de souffre fondée sur la valeur entière de la vitesse de roulement (S12, S13).

9. Dispositif de purification de gaz d'échappement selon l'une quelconque des revendications 1 à 8, **caractérisé en ce que** le mécanisme (3, 4, 14) comprend un injecteur de carburant (3) qui injecte du carburant, une bougie d'allumage (4) qui allume le carburant et une soupape de recirculation du gaz d'échappement (14) qui recycle une partie du gaz d'échappement du moteur (1) en un air d'admission du moteur (1), et dans lequel le mécanisme (3, 4, 14) supprime les oxydes de souffre du catalyseur à piégeage de monoxyde d'azote (5A) en enrichissant un rapport air-carburant de l'air d'admission et du carburant en augmentant la quantité d'injection de carburant de l'injecteur de carburant (3), et en élevant la température du gaz d'échappement en retardant l'instant d'allumage de la bougie d'allumage (4) et en fermant la soupape de recyclage du gaz d'échappement (14).

10. Dispositif de purification de gaz d'échappement selon la revendication 9, **caractérisé en ce que** le dispositif de commande (6) est programmé, en outre, pour faire varier une richesse du rapport air-carburant basé sur la quantité d'empoisonnement aux oxydes de souffre pendant le fonctionnement du mécanisme (3, 4, 14) (8101, S102).

11. Dispositif de purification de gaz d'échappement selon la revendication 10, **caractérisé en ce que** le dispositif de commande (6) est programmé, en outre, pour diminuer la richesse du rapport air-carburant lorsque la quantité d'empoisonnement aux oxydes de souffre diminue pendant le fonctionnement du mécanisme (3, 4, 14)(S101, S102).

12. Dispositif de purification de gaz d'échappement selon l'une quelconque des revendications 1 à 11, **caractérisé en ce que** le dispositif de commande (6) est programmé, en outre, pour établir la quantité de diminution par unité de temps de la quantité d'empoisonnement aux oxydes de souffre pendant le fonctionnement du mécanisme par l'équation suivante :

$$RSMILE = SOXMILE_{-1} \cdot RSMILE1 + RSMILE2$$

où,
RSMILE = la quantité de diminution par unité de temps,
$SOXMILE_{-1}$ = la quantité d'empoisonnement aux oxydes de souffre SOXMILE à une unité de temps en arrière, et
RSMILE1 = un coefficient qui diminue lorsqu'un temps écoulé depuis le démarrage des moyens de suppression augmente et
RSMILE2 = un coefficient qui augmente lorsque le $SOXMILE_{-1}$ augmente.

13. Procédé de purification de gaz d'échappement pour un véhicule automobile (1), le moteur (1) comprenant un catalyseur à piégeage de monoxyde d'azote (5A) qui piège les oxydes d'azote dans le gaz d'échappement, des moyens (3, 4, 14) pour supprimer les oxydes de souffre ayant empoisonné le catalyseur à piégeage de monoxyde d'azote (5A) du catalyseur à piégeage de monoxyde d'azote (5A), le procédé comprenant :

la détection d'un état de roulement du véhicule ;
le calcul d'une quantité d'empoisonnement aux oxydes de souffre du catalyseur à piégeage de monoxyde d'azote (5A) à partir de l'état de roulement du véhicule ;
le démarrage du fonctionnement des moyens de suppression (3, 4, 14) lorsque la quantité d'empoisonnement aux oxydes de souffre atteint une quantité prédéterminée ; et
l'arrêt, après que le fonctionnement du mécanisme de suppression (3, 4, 14) a démarré, du fonctionnement des moyens de suppression (3, 4, 14) lorsque la quantité d'empoisonnement aux oxydes de souffre a diminué à une valeur prédéterminée équivalente à l'achèvement de la désulfuration,

caractérisé par l'établissement d'une quantité de diminution par unité de temps de la quantité d'empoisonnement aux oxydes de souffre pendant le fonctionnement des moyens de suppression (3, 4, 14) comme paramètre basé sur la quantité d'empoisonnement aux oxydes de souffre ; et
le calcul de la quantité d'empoisonnement aux oxydes de souffre pendant le fonctionnement des moyens de suppression, basé sur une valeur entière de la quantité de diminution par unité de temps.

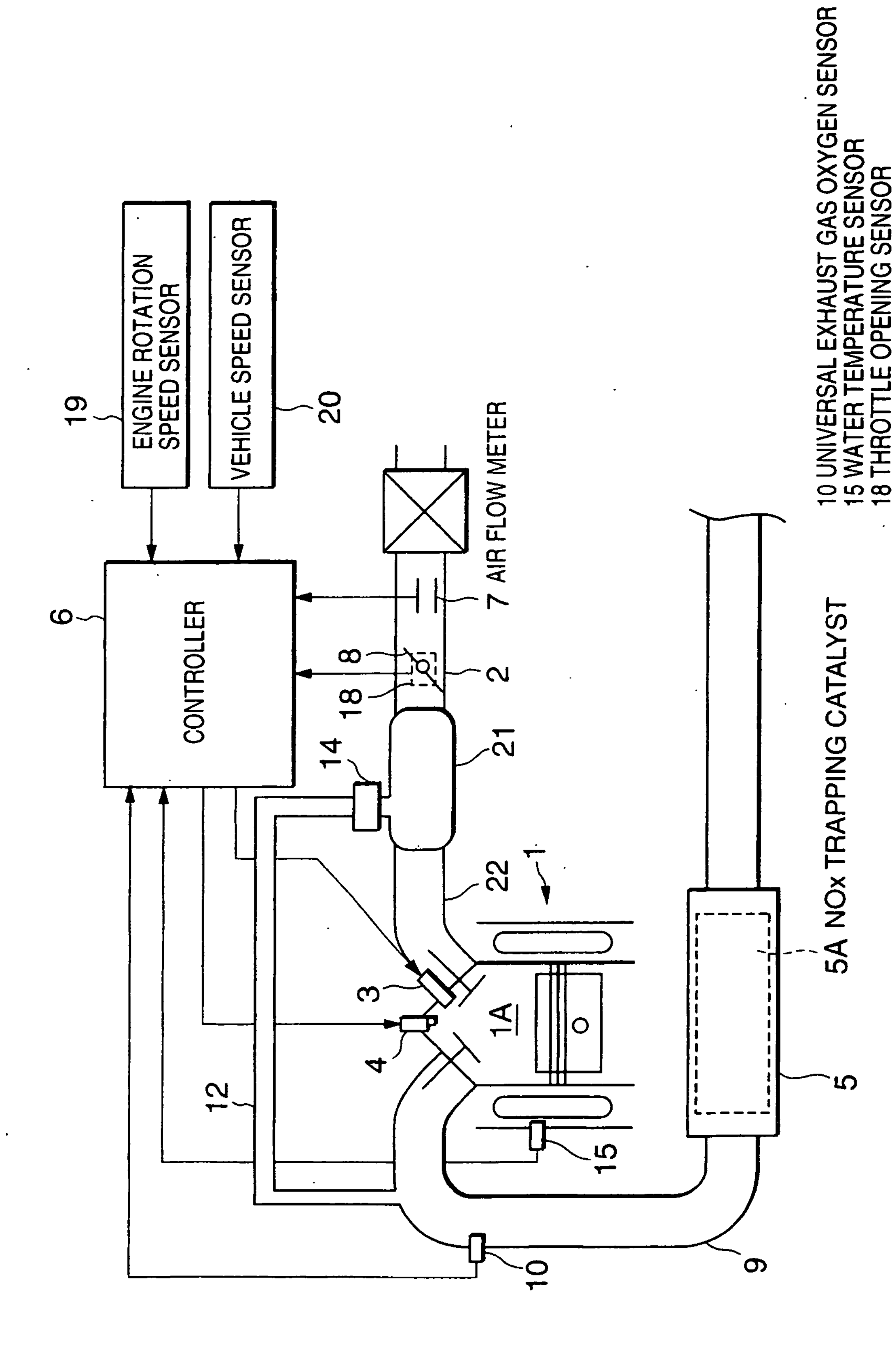
ENGINE ROTATION SPEED SENSOR
19
VEHICLE SPEED SENSOR
20
CONTROLLER
6
7 AIR FLOW METER
8
2
18
14
21
22
1
3
4
1A
12
15
5
5A NOx TRAPPING CATALYST
10
9
10 UNIVERSAL EXHAUST GAS OXYGEN SENSOR
15 WATER TEMPERATURE SENSOR
18 THROTTLE OPENING SENSOR

FIG. 1

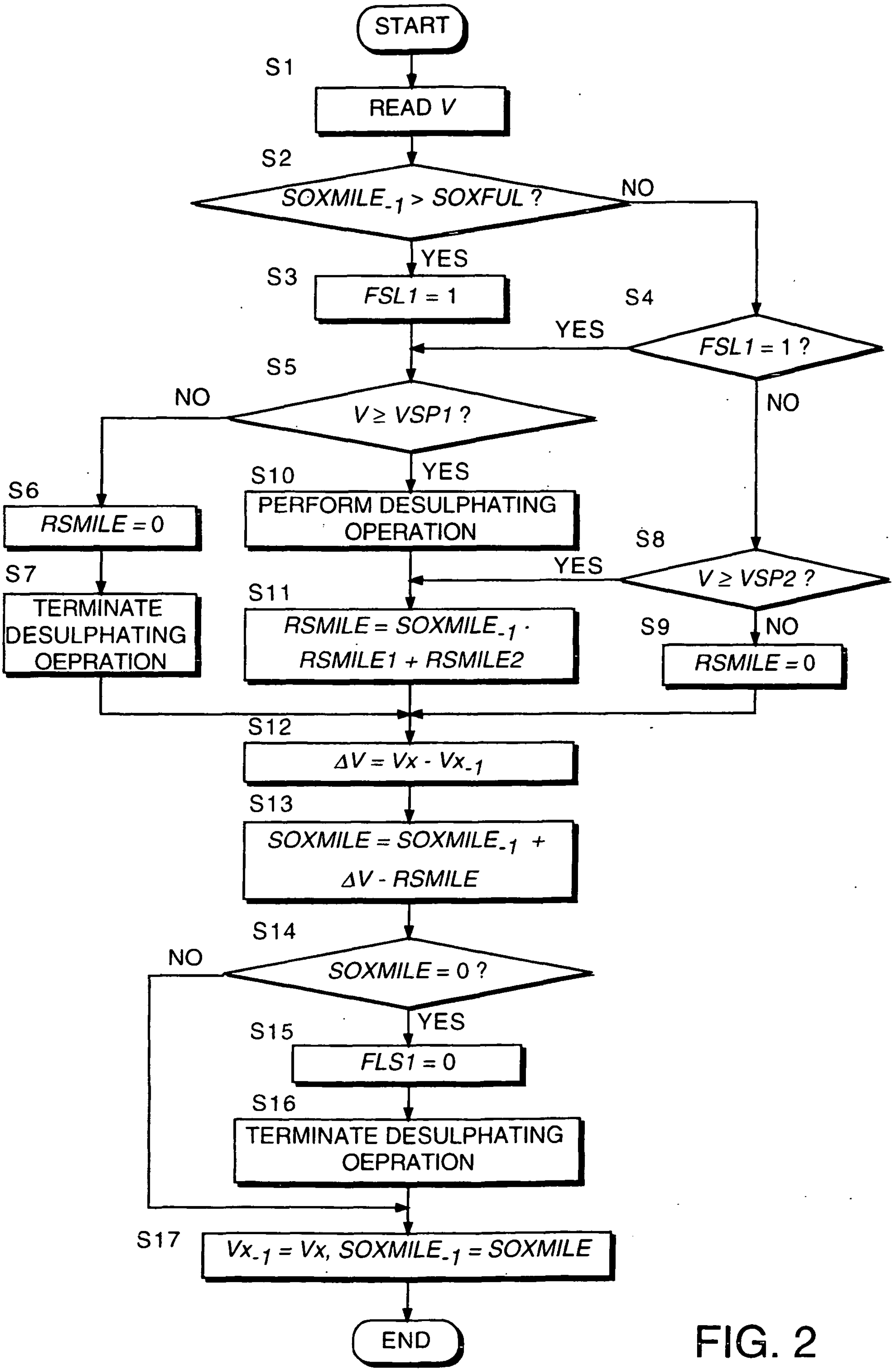
START
S1
READ V
S2
SOXMILE-1 > SOXFUL ?
NO
YES
S3
FSL1 = 1
S4
YES
FSL1 = 1 ?
S5
NO
V ≥ VSP1 ?
NO
S6
RSMILE = 0
S10
YES
PERFORM DESULPHATING OPERATION
S8
YES
V ≥ VSP2 ?
S7
TERMINATE DESULPHATING OEPRATION
S11
RSMILE = SOXMILE-1 · RSMILE1 + RSMILE2
S9
NO
RSMILE = 0
S12
ΔV = Vx - Vx-1
S13
SOXMILE = SOXMILE-1 + ΔV - RSMILE
S14
NO
SOXMILE = 0 ?
YES
S15
FLS1 = 0
S16
TERMINATE DESULPHATING OEPRATION
S17
Vx-1 = Vx, SOXMILE-1 = SOXMILE
END

FIG. 2

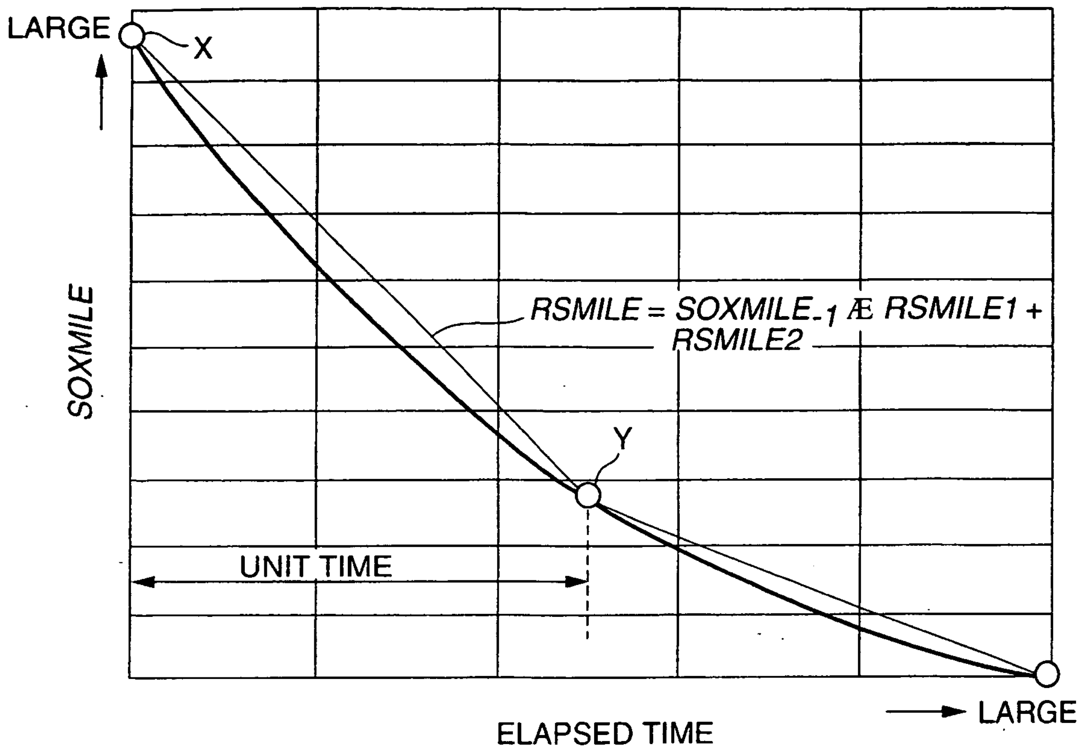
LARGE
X
SOXMILE
RSMILE = SOXMILE-1 Æ RSMILE1 + RSMILE2
Y
UNIT TIME
ELAPSED TIME
LARGE

FIG. 3

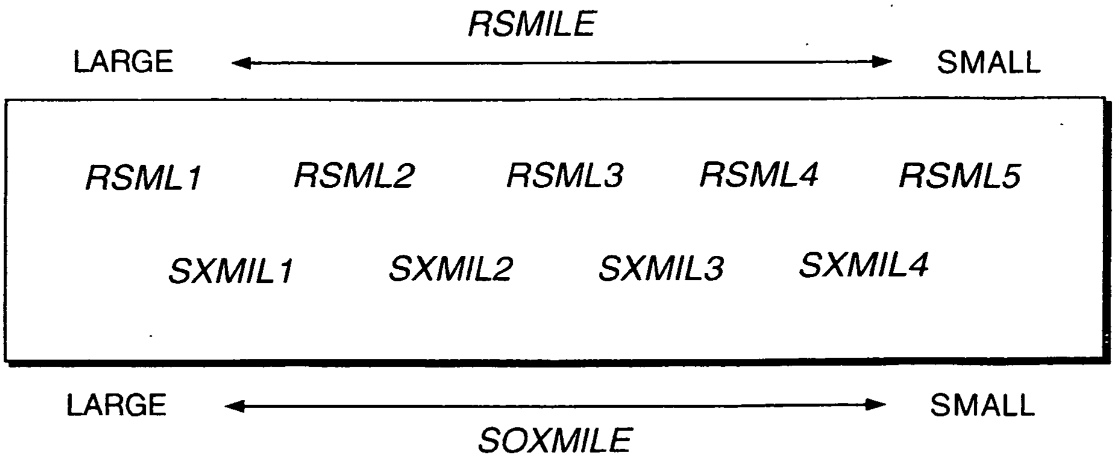
RSMILE
LARGE
SMALL
RSML1
RSML2
RSML3
RSML4
RSML5
SXMIL1
SXMIL2
SXMIL3
SXMIL4
LARGE
SMALL
SOXMILE

FIG. 4

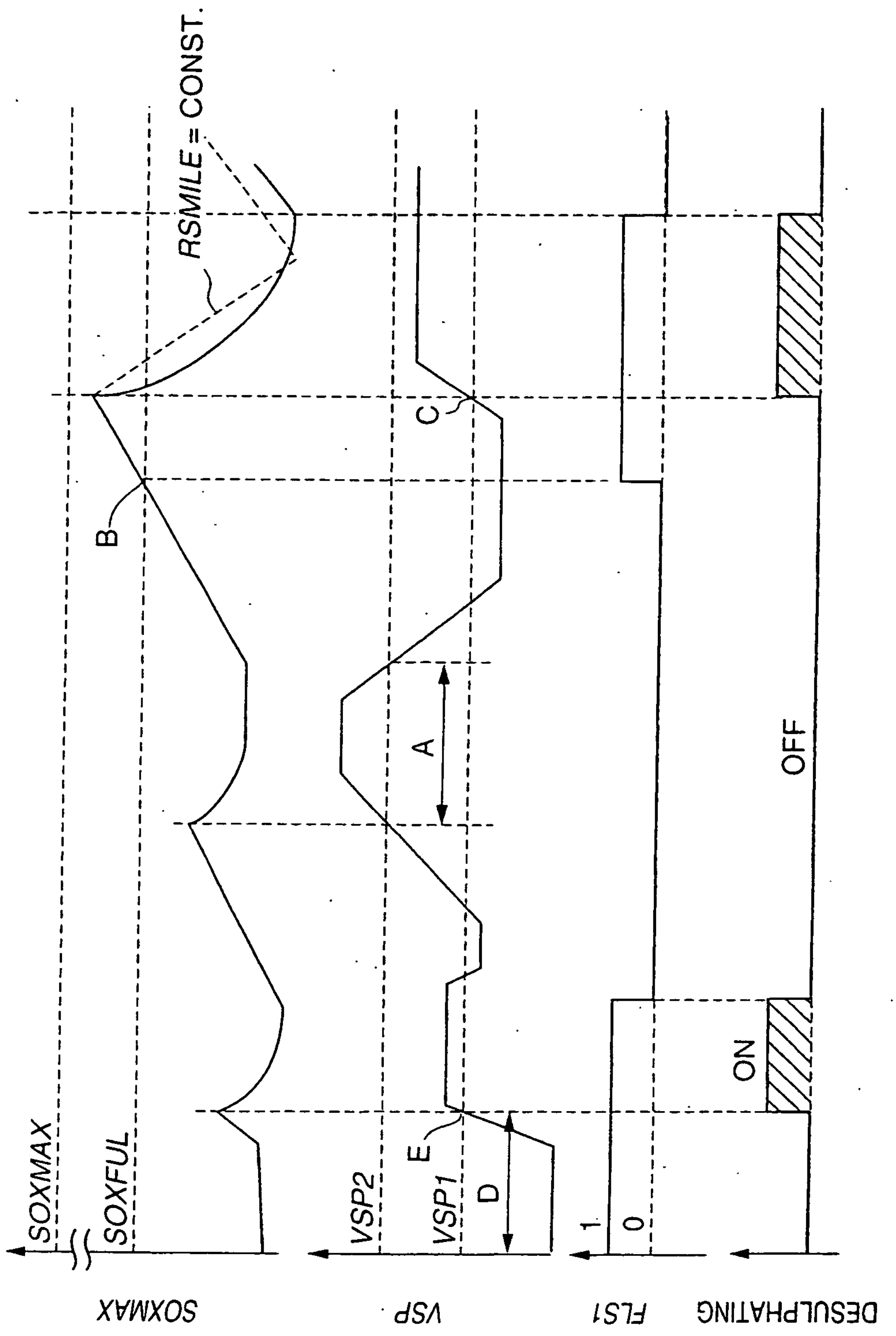

FIG. 5A

FIG. 5B

FIG. 5C

FIG. 5D

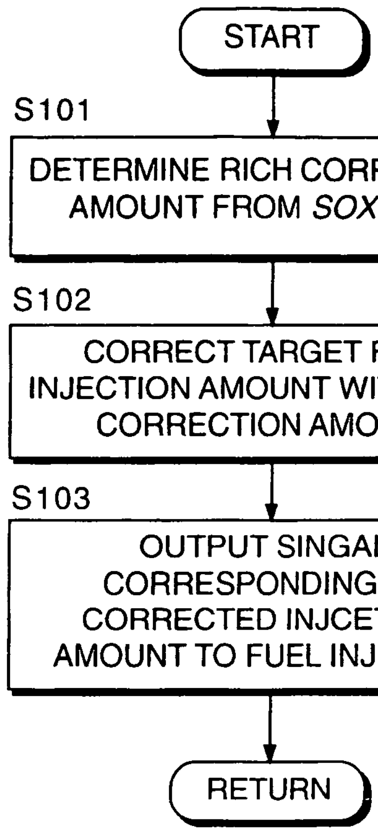
START
S101
DETERMINE RICH CORRECTION AMOUNT FROM SOXMILE-1
S102
CORRECT TARGET FUEL INJECTION AMOUNT WITH RICH CORRECTION AMOUNT
S103
OUTPUT SINGAL CORRESPONDING TO CORRECTED INJCETION AMOUNT TO FUEL INJECTOR
RETURN

FIG. 6

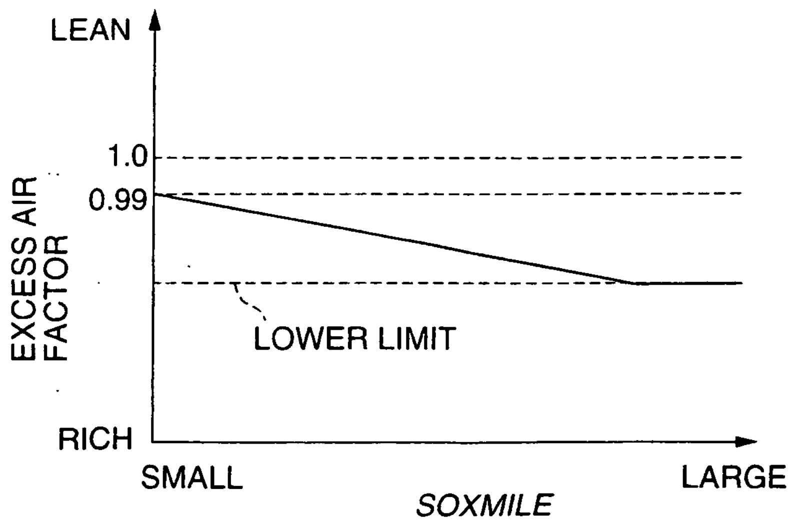
LEAN
1.0
0.99
EXCESS AIR FACTOR
LOWER LIMIT
RICH
SMALL
LARGE
SOXMILE

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 1059428 A2 **[0002]**